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being

Summary of Contents, Translation of Author's Summary (annotated) and of Appendix 2 of

EXPERIMENTAL DATA ON ORCHARD AND SMALL FRUIT MANURING

by

S. T. ANTOSHIN.

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FERTILIZATION AND CROP

Summary of the results obtained from field experiments with fertilizers.

XVI

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Experimental Data on Orchard and Small Fruit Manuring

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S. T. ANTOSHIN.

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TRANSLATION OF AUTHOR'S SUMMARY
(ANNOTATED)

The chief source of the data discussed in this paper is the U.S.A., while others come from Canada, England, Germany, U.S.S.R., France, Switzerland, Australia, etc. The greatest number are available on the manuring of apples, strawberries, peaches and citrus. Data on pears, cherries, plums, raspberries, currants and gooseberries are fewer, while those on the manuring of apricots, quinces, sweet cherries, figs, Japanese Persimmon (*Diospyros Kaki*), almonds and nuts were entirely absent or actually unavailable to the author. Much of the information was available only in abstracts and hence did not contain such figures as would have made it possible to obtain any constants of manurial efficiency based on averages of the different trials.

In any case the value of such constants, even had the necessary figures been available, would have been purely relative owing to the extraordinarily different conditions obtaining in the different trials and the actual scarcity and diversity of arrangement of the trials made.

Hence it was only possible to draw conclusions of a qualitative character. Those dealing with the chief experiments for which figures are available are shown in tabular form.

It would appear that stable manures, mixed manures, and minerals containing nitrogen are likely to be most efficient. The importance of N may be attributed to the need for it at the time of fruit setting in early summer and later for fruit bud formation.

The effect induced by the addition of nitrogen is found to vary from 0—300 per cent increase. The absence of effect has been most marked in orchards under clean cultivation (both irrigated and unirrigated), where cover cropping is practised—possibly the best system of orchard management. Its greatest effect has been on orchards under sod, especially where the grass is removed. Sod + N, especially when sod mulching is practised, is often found to be as good, if not better than clean cultivation + cover cropping.

Citrus reacts particularly strongly to N, peaches and other stone fruit come next, followed by apples and pears, though as regards the last excessive N tends to promote disease.

The widespread fear that N stimulates exclusively vegetative growth at the expense of fruit bearing, such growth moreover being conducive to damage by frost, while not entirely groundless, is much exaggerated.

[The danger of over stimulation by nitrogenous fertilizers is apparently much greater under English conditions than in U.S.A., whence Antoshin's data are mainly derived. In England fruit plants, especially apples, are frequently over-nitrogenous without the addition of nitrogen. This condition results in over-vigorous growth, accompanied by lack of quality; stunting where K is low; increased susceptibility to canker and scab.—ED.]

Although P has been proved effective only in a few isolated cases and then probably only in the presence of N, more cautious workers do not recommend its omission.

K has been found effective very occasionally, chiefly in England or France, which may be due to the dull climates of those countries. It should be noted, moreover, that PK has often had a definitely adverse effect. This may be due to faulty methods of application, as there are indications that the addition of P and K to leguminous cover crops is very important.

[For examples of K deficiency in Holland, Germany, Australia, Denmark, South Africa and U.S.A. see the following references :—

Red Currants	HOLLAND ..	Die Ernährung der Pflanze, Band 25, p. 297, July 1st (1929).
Red Currants	GERMANY ..	Die Gartenbauwissenschaft, Band 5, p. 508 (1931).
Gooseberries	,, ..	Die Ernährung der Pflanze, Band 26, p. 269, June 15th (1930).
Gooseberries	AUSTRIA ..	Ibid. Band 28, p. 440, Dec. 15th (1932).
Black Currants	,, ..	
Red Currants	DENMARK ..	Tidsskrift for Planteavl, Band 36, p. 291 (1930). Ibid, Band 37, p. 729 (1931).
Apples	SOUTH AFRICA. .	Die Ernährung der Pflanze, Band 28, p. 382, Nov. 1st (1932).
Prunes	CALIFORNIA ..	Proc. of 1st Internat. Congr. Soil Sc., Washington, p. 390 (1927).—ED.]

Contradictory data from the U.S.A. and Germany leave the question of the necessity for applying lime still unsettled.

As regards the best forms of mineral fertilizers it is found that sodium nitrate and sulphate of ammonia are about equally efficient. Possibly the practice of giving them alternately to trees not having the biennial bearing habit may be recommended. Norwegian nitrate (a synthetic nitrate of lime) must also be seriously considered in this connection.

No data are available on the best forms in which to apply P, K, or Ca.

[But see reference in last editorial note as regards the best form of potash. In the two German and the Danish articles referred to above there is evidence of the superiority of the sulphate to the chloride. In all of them Cl injury to red currants is recorded. There have been also several cases recorded of damage resulting from the use of KCl and kainit on soft fruits in England. Again sulphate of potash has been found on the whole superior to kainit as a manure for raspberries at East Malling. *J. Pom. Hort. Sci.*, 1931, Vol. IX, pp. 303-30.—ED.]

As regards amounts, dates and methods, the data available, which are as yet only empirical, suggest the yearly application of mineral manures early in spring, i.e., 2—3 weeks before flowering, broadcasting them on the area or a little exceeding the area covered by the spread of the tree at the rate of 60—120 kg. per ha. (approx. 53.4—106.8lbs. per acre) of N, P_2O_5 and K_2O, (higher doses in the case of citrus). The application of fertilizers to pits at planting or to furrows round the tree which are apt to endanger the root system should be avoided. P, when used in normal doses, may be an exception to this ruling.

Green manuring has been proved useful in the U.S.A., and stable manures have also proved their worth, but the value of such other organic manures as liquid manure, industrial waste products, peat, etc., has not been definitely proved. Experiments with apples in Pennsylvania and citrus in California have shown the necessity for maintaining the organic content of orchard soils.

As regards the influence of manuring on quality of fruit, N is known to be liable to decrease colour and probably increase size.

[Under English conditions where N is excessive fruit size may be decreased. There appears to be an optimum level for N for particular cases.—ED.]

The effect of manuring on susceptibility to frost, to diseases and to pests has not yet been determined.

Small fruit crops, according to American data, react less favourably to mineral fertilizers. This may possibly be explained in the light of Junge's data by the fact that they are surface rooters and hence easily harmed by excessive doses of fertilizer.

Strawberries show this tendency to a marked degree, but in this case careless application, i.e., so that fertilizer falls on the leaves, is partly to blame. Even in the absence of stable manure minerals have only rarely increased the strawberry crop by 50—60% and more usually only increased it by 20—30%.

Raspberries, gooseberries and currants appear to react more readily. Strawberries appear to react to N, and P, while research at Long Ashton indicates the possible importance of Mg to this crop.

[This remark refers to results of pot experiments. In field experiments at Long Ashton the best results have been obtained from dung, but effects can be distinguished both on yield and quality from N, P and K respectively. Some of the latest Long Ashton results indicate that P is very important for strawberries. See also article by Knight, Lucy D.M. and Wallace, T. in *J. Pom. Hort. Sci.*, 1932, Vol. X, pp. 147-80.—ED.]

Raspberries are usually found to react strongly to N, but very little to P and K.

[Results in England at East Malling, *J. Pom. Hort. Sci.*, 1931, Vol. IX, pp. 303-30, and at Long Ashton tend to show that raspberries are susceptible to K deficiency.—ED.]

Stable manure has been proved useful for currants as also N and K, but P has been found to be ineffective.

Gooseberries are notable for their strong reaction to K, other trials show that they make a good return for organic manuring such as stable manures and dried blood.

The problem of replacing stable manuring by a complete mineral manuring remains unsolved despite such successful results as were obtained with minerals at Mysovsk Station, Siberia.

The best forms, doses and methods of application remain still undetermined in the case of small fruits. Doses adopted in trials vary immensely.

When formation of fruit buds is the aim, American and German data suggest that autumn application may be superior to that in summer and spring for strawberries and raspberries.

There are no experimental data available on the value of green manuring or peat to small fruit crops.

Data on lime application to strawberries and raspberries lead to no definite conclusion, but currants and gooseberries are found to react strongly to lime.

[Only one experiment has been carried out at Long Ashton on liming gooseberries. This was on an acid soil. The results were negative, although K on the same land gave a strong reaction.*—ED.]

The application of mineral manuring in nurseries has not given positive results in most trials. Such trials, however, have been few and cannot be regarded as reliable.

The above conclusions need testing before being applied under the varied conditions obtaining in U.S.S.R., though they do point to the lines which such investigations should follow.

The first problem which needs attention is the use of green cover crops as manure and the selection of such crops. Testing the efficiency of N is also of primary importance. Both these problems together with the testing of P and K on a five-fold scheme have been included in the programme of the Geographical Network of the Fertilizer Institute for 1930, this being the senior fertilizer institute in the Union.

It appears desirable that mass trials should be laid out on these lines on the state farms and the collective farms on a larger scale but with simplified methods and abridged schemes, e.g., O—N ; O—PNK ; Clean cultivation—Cultivation—Cover cropping—Sod or sod mulch + N ; O—peat—peat + PNK.

Other problems which merit trial in the near future are : the application of peat especially to small fruit crops, replacement of stable by mineral manures, the proper doses of PNK and N, the application of lime, and forms of P and N and compound fertilizers. Preliminary pot trials are also desirable on the effects of S, Mg and Mn, and possibly other elements.

The best methods of plot layout so as to ensure uniformity of plots need determination and might follow experimental work in that field in the U.S.A. It is suggested that for apples 2—3 such trials might be set up in Ukraine, in the Central Black Soil Region, and in Central Asia, for Southern stone fruits 3—4 trials in Ukraine and Central Asia and 1—2 trials for cherries in the podsol zones. Trials on these lines for small fruits are particularly desirable in the podsol zone and in the nurseries of Ukraine and the Central Black Soil Region.

TRANSLATION OF APPENDIX II.

Resolutions passed at the conference on trials with orchard, gardening and sub-tropical crops, held at the Scientific Institute on Fertilizers on March 3—5th, 1930.

I. That the necessity is realized for the laying out of manurial trials on fruit trees, both mature and bearing and newly planted trees. Conditions giving the best promise are to be found in orchards newly laid out in Sovkhoz and Kolkhoz.

*Results not yet published.

II. The following kinds of fruit should be used in the trials :—In the non-black soil regions, the Central Black Soil (Chernozem) and in the Central Volga regions : apples and cherries. In the Lower Volga region : apples. In Ukraine : apples (in the South : cherries, apricots and plums). In Crimea : apples and pears (on the South coast : peaches). In Northern Caucasus : apples, pears, plums, cherries. On the Black Sea Coast of Caucasus : plums, peaches, " funduk " (kind of nut) and mandarines. In Transcaucasus : apples, pears, apricots (Arminia), " funduk," walnuts. In Central Asia : apples, apricots, almonds.

III.—Initially the following centres are suggested for research work : Mleev Station (pome fruits), Melitopol (stone fruits), Salghir (apples), Sochi (plums), Sukhum (mandarines), Kursk (apples), Mysovsk (apples and small fruits), Saratov (apples), Vladimir (cherries), Kazan (apples), and the Uzbek Station (apples and stone fruits).

IV. Varieties to be tried should be commercial and standardized for the region in question. As far as apples are concerned, special attention should be devoted to winter varieties. Trials are desirable also with varieties which do not tend to annual bearing and those which come into fruit bearing late.

V. The manurial treatments should be given once a year, early in spring, while at the same time N trials with varying doses at different times should be undertaken.

VI. Manures should be applied over the whole area both in mature and in young orchards—in the latter case when there is an intermediate crop and at 1.5 m. from the trees. Depth of manure may vary according to local conditions. Special trials on method of application and on depth of manure are desirable.

VII. The age of the mature trees involved in the trials should be between 20 and 35 years.

VIII. The maximum thinning should be 20 per cent.

IX. In view of the fact that methods of layout are still wanting, it is highly desirable that such methods should be elaborated.

X. The number of mature trees in experimental plots should not be less than 6, and plots should be repeated 3 times : in addition uniformity of trees, soil and soil surface should be the aim.

XI. The shape of the plot may vary with the topography and the actual position of trees under trial.

XII. The minimum guard-zone should be a single row of trees.

XIII. In abridged binomial schemes (such as O—N, O—PNK, etc.), the pair of trees method should be tested, each pair being selected according to the character of growth and, if possible, a preliminary record of yield for 1—2 years (Anthony, *Proc. Amer. Soc. Hort. Sci.*, 1926, pp. 71-3).

XIV. Records, which should be individual for each tree, should include not only the yield (quality and quantity, and the weight of fallen fruits) but also increment in growth, increase in length and girth of trunk. In addition, phenological observations as well as observations on ento-phytological factors should be made.

XV. Trial plots in new plantations should be laid out at the time of planting. A special feature of these trials should be the large number of trees used, e.g., not less than 100 trees for each type of manuring, with at least fourfold replication. The method of recording adopted in such trials might be somewhat simpler than in the case of mature tree trials ; but individual records of yield and growth (at least of trunk girth) should, however, be retained. In the layout of these trials it is desirable (by increasing the number of control plots) to make it possible to record the influence of manuring which is given not at the beginning of the trial but when the trees have reached an age of 10—15 years.

XVI. In discussing the programme suggested by the Scientific Institute on Fertilizers and dealing with the trials to be carried out by the Geographical Research Net, the following four schemes have been adopted both for mature and young orchards.

(1) Object: the requirement of nutritive substances.
Scheme: O—NP—NK—PK—NPK.
Rate: 60 kg. of N, P_2O_5 and K_2O. (53·4 lbs. per acre).

(2) Object: the comparison of stable with mineral manures.
Scheme: O—Stable manure 36 m.—PNKCa (=36)—$\frac{1}{2}$ stable manure + $\frac{1}{2}$ PNKCa.

NOTE.—Analysis of stable manure samples should be done, when possible, in local laboratories; the sending (in exceptional cases only) of stable manure samples for analysis to the Research Institute for Manuring should be carried out in accordance with existing rules.

(3) Object: the influence of lime (alone or in the presence of PNK at the rate of 60 kg of N, P_2O_5, and K_2O (53·4 per acre).

Scheme: O—PNK—PNK Ca_1—PNK Ca_2 or O—Ca_1—Ca_2.

The amount of lime is determined by hydrolytic acidity (Ca_1). In addition to this dose, one or two smaller doses (50 and 75 per cent. of the principal one) should be introduced into the scheme.

(4) Object: The influence of mineral and green manures.

Scheme: Clean cultivation — annual legumes for green manuring.

O—P_sK—P_fK O—P_sK—P_fK

Note: P_s=superphosphate, P_f=phosphorite, K_k=pot. salts.

Rate: P_s and K_k in amounts containing 60 kg. P_2O_5 and K_2O respectively:
P_f in amounts containing 120 or 180 kg. P_2O_5.

In paired combinations the addition of N (on cultivating) is possible. The choice of crops for green manuring, the time of their sowing and ploughing in should agree with local conditions. In case of difficulty one form of P may be omitted.

XVII. The choice of manurial forms to be adopted in these trials is made by the Scientific Institute on Fertilizers in accordance with the industrial prospects of the region in question.

XVIII. A more detailed study of the influence of manuring is not included in the programme, but it is desirable that trials relating to doses, methods and date of manurial treatment should be laid out at the individual experiment stations.

XIX. In regions where fruit crops are irrigated, the method of irrigation chosen should be typical for the region concerned.

XX. A detailed programme of agro-chemical and physiological investigations relating to manurial trials on manuring should be elaborated. When plots are being laid down in new plantations it is recommended that unplanted plots 450 m^2 should be left unplanted with a view to studying agro-chemical processes connected with the cultivation of orchard trees.

XXI. The analogy method also needs investigation. Here annual field crops, sown under identical conditions, might by their response to manures show the manurial requirements of orchard crops.

XXII. The following problems require elaboration by individual research stations in collaboration with the Central Institute: (a) identification by labelling or marking of orchard trees at the time of laying out trials; (b) the actual records necessary to test manurial efficiency; (c) recording technique; (d) method of recording in young non-bearing plantations.

XXIII. In order to establish budget norms relating to the layout of trials with orchard trees, representatives of all experiment institutions present at this conference are requested to calculate the preliminary estimate of costs on the subject not later than March 15th, 1930.